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# Physico-Chemical Analysis of Various Samples of Tomato Ketchup

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author PPN has guide, evaluate and interpret the results, supervised the project, write and proofread the manuscript. Authors FHAM, MAAR and NAAG designed the study, performed all experiments work and collect literature material during the study tenure. All authors read and approved the final manuscript.*

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## ABSTRACT

Aim of our present study was to analyze physico-chemical properties of tomato ketchup samples available in the local market. Major part of tomato consumption comes under processed products like tomato juice, ketchup and sauce. Recent studies have indicated the potential health benefits of a diet that are rich in tomatoes. Study of various physico-chemical parameter testing of four different types of tomato ketchup samples. Study was performed in Department of Applied Sciences, Chemistry section, University of Technology and Applied Sciences, Muscat, Oman during the September 2017 – April 2018.

We have selected four different tomato ketchup samples from the local brand and tested for their various physical and chemical parameters such as, pH, conductivity, viscosity, solubility, acidity total, moisture, ash, vitamin C, sodium, potassium, calcium and magnesium. We have used routine and simple techniques for analysis. Such as some chemical methods, Flame photometer etc. We have found that, pH was in the range of 3.6 – 3.8, conductivity 5.38 – 8.71 MS/cm, viscosity 3.93 –

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6.76 Pa s, solubility 53.35 – 61.12, titratable acidity 3.2 – 4.01 g/100 gm, (pH metric 3.6 – 4.3 g/100 gm), ash 1.62 – 2.98%, vitamin C 17.25 – 55.23 mg/100 gm, sodium 294.5 – 475.85 ppm, potassium 93.5 – 153.3 ppm, magnesium 106 – 163 ppm, calcium 67 – 117 ppm. The result found in our analysis was more or less close to each other. On the basis of result obtained during the analysis of four tomato ketchup samples Jumbo sample was good amount of vitamin C, less ash value lowest sodium content.

*Keywords: Tomato ketchup; physico-chemical analysis; mineral analysis; viscosity.*

## 1. INTRODUCTION

Tomatoes are the one of the important vegetable using in daily meal around the world. Tomatoes are the second most important crop after potatoes around the world and most of them are consumed as processed tomatoes such as tomato paste, sauce and ketchup [1]. The leading countries in fresh tomato production are China, USA and India. China accounts for the 25% of the world´s production and cultivating area, being also the largest consumer, while USA, Italy, Spain and Turkey are the largest tomato processors. USA is the second largest producer of fresh tomatoes and the first one in production and exports of tomato products [2]. Tomatoes can be used as vegetables as well as it can also be served in different format such as jam, ketchup, pulp, paste, juice etc. There is a very less difference in composition and taste among all these products.

Tomatoes are considered an important agricultural crop and an integral part of the human diet. Tomatoes are commonly consumed fresh, but major part of tomato consumption comes under processed products. Recent studies have indicated that potential health benefits of a diet that are rich in tomatoes. Lycopene, a major carotenoid without provitamin an activity, present in red tomatoes, is considered responsible for their beneficial effects [3,4].

Each vegetable group contains a unique combination and amount of these phytonutriceuticals (strong antioxidants), vitamins, minerals, dietary fiber, and phytochemicals which distinguishes them from other vegetables. Vegetables have been strongly associated with improvement of gastrointestinal health, good vision, and reduced risk of heart disease, stroke, chronic diseases such as diabetes, and cancer. The promotion of healthy vegetable products has coincided with a surging consumer interested in the healthy functionality of food [4].

Ketchup is the product that is made from tomato paste after diluting on 15% of the soluble solids. It is mixed with sugar, salt, vinegar, spices, red pepper extract or also some other ingredients are added such as onion, garlic, extracts of spiced herbs. Commercial ketchup can have an extremely variable composition; nearly all manufacturers have a formula of their own which differs in some respects from those of other manufacturers. These differences are mainly in the quantity, number and amount of spices or other flavoring agents used [5]. Ketchup is a commonly consumed foodstuff. Ketchup has important ingredients that is lycopene content and related beneficial properties. Ketchup having varying in nutritional and sensory quality in European market. Sensory quality is of the primary importance as the majority of consumers are most aware of this quality aspect [6].

The stability of the tomato ketchup was studied by Kumar V (2015) and it was found that, ketchup stored in the refrigerator ($5^0$C) samples was found superior as compared to the room temperature. It was also found that, there was gradual increase in Total Soluble Solids (TSS) and pH at the same time acidity and ascorbic acid were decreased [7]. Consumer acceptance and behavior when buying tomato products is influenced by the nutritional value, the sensory characteristics such as flavor, bright red color, good aroma etc. and consistency with high acidity. Content of the tomato in ketchup significantly affect the density and viscosity of ketchup. Increasing of tomato content in ketchup will increase density and it will apparently increase the viscosity of ketchup [8]. Viscosity is used to measure non-Newtonian fluids and it quantifies the resistance applied by a fluid product to the relative motion of its components [9].

Karla Ariane et.al study show that the quality of tomato paste or products in terms of ascorbic acid, color and consistency affects exposer of sunlight and industrial processing chain [10]. One research has shown that novel processing

technology would yields high quality, better nutrients and longer shelf life of tomato products [11]. The tomato cultivar used during the processing of tomatoes is the most important factor which will be related to product consistency. It is also possible to find differences in products consistencies from the same cultivar if the tomatoes grown in different locations or have been harvested at different maturity stages [9].

According to Andrea [1], it is very difficult to define and establish analytical quality parameters for testing of quality of tomato ketchup because of different manufacturer will use number and amount of various spices or other flavoring agents. It does mean that there is no any standard for testing of quality of tomato ketchup. Acid content and pH are important quality parameters that outline tomato products characteristic such as flavor by defining the tartness component of the flavor. Quality of product is affected by pH since the pH modifies the total pectin content and its characteristics. On the other hand, acids and pH are important inputs to define processing time and temperature, which would be useful for other quality characteristics [9]. According to Radoslav Zidek and Vladimir Vietoris [12] survey research showed that texture plays a vital role in consumer's choice for ketchup product. Texture is used for quality control criteria of ketchup. It's a very complex property and is probably not perceived solely as viscosity or consistency.

## 2. MATERIALS AND METHODS

### 2.1 Sample

We have selected four different samples of tomato ketchup from the local super market namely Al Hana, Hayat, Khabura and Jumbo. Different physico-chemical and elemental parameters were studied for selected tomato ketchup samples. Parameters were tasted with routine chemical and instrumental analytical methods such as pH, conductivity, solubility, titratable acidity, ash content, viscosity, moisture and some elemental analysis such as sodium, potassium, calcium and magnesium.

pH, conductivity and density was measured by using routinely used pH meter, conductivity meter and picnometer available in our laboratory. pH of all samples were measured by using Mettler Delta 320 pH meter. pH meter was calibrated with two standard buffer solution of pH 4.0 and pH 7.0. Conductivity of the samples were measured by using conductivity meter TS Orion 4 – Star. Conductivity meter was calibrated by using standard conductance solution.

All readings of samples were recorded triplicate and average of three readings were used for final calculation. Acidity (titratable) of the samples were determined by simple acid base titration. Standard NaOH solution was used to titrate with sample in presence of phenolphthalein indicator. Acidity also measured by using pH metric titration, where we used the pH of this solution after every addition of NaOH and pH was recorded until we found stable reading. We recorded graph and found out the equivalence point of titration. Ash was measured by combustion of samples in furnace at 550°C for about 5 hours in preheated and weighed crucible till the white ash was obtained. Physico chemical parameters were measured according to AOAC, 2005 [13].

Ascorbic acid (vitamin C) was determined by oxidation – reduction titration (iodometric titration) of sample with standard iodine solution and starch as an indicator. Standardization of iodine was done by using standard ascorbic acid and final amount of vitamin C was calculated in mg/100 gm of sample.

### 2.2 Mineral Analysis

All samples were used to measure the amount of sodium and potassium by using flame photometer. Standard solution of sodium and potassium were prepared by using exact quantity of sodium chloride and potassium chloride salts respectively. Then emission intensity of standard series of solutions of sodium and potassium along with their samples measured at respective wavelength. Calibration curve was obtained with concentration of standard sodium with emission intensity and same for potassium. Equation of straight line and $R^2$ value for both sodium and potassium were obtained and used for calculation of amount of sodium and potassium in mg/100 gm of sample.

Calcium and magnesium was obtained by using EDTA titration. EDTA was standardized by zinc chloride solution in presence of eriochrome black T indicator. Then samples were prepared for titration. Samples were titrated with standard EDTA and eriochrome black T and murexide indicator. The amount of EDTA required for

titration was recorded and then quantity of calcium and magnesium was measured.

## 3. RESULTS AND DISCUSSION

The physical and chemical analysis of four different tomato ketchup samples shows there was very less deviation between results. The results of different parameters with standard deviation values are shown in Table 1. While the Fig. 1 represents comparison between different parameters tested for tomato ketchup. The pH found for the four different samples were in the range of 3.6±0.07– 3.8±0.09. pH is the main quality parameter of tomato ketchup. Acidic pH was due to presence of different organic acids (citric, malic and ascorbic acid etc.) in the sample and preservatives used during manufacturing process. Acidity also measured by pH metric titration Fig. 5 shows representative pH metric curve of the titration. Conductivity was found to be in the range of 5.38±0.015 – 8.71±0.02 MS/cm. This is due to presence of various mineral cations and anions. We found there was correlation between amount of Sodium and conductivity. Khabura sample which was high in sodium content was possess highest amount of conductivity. While Jumbo and AL Hana sample was found to lowest amount of sodium and so conductivity.

**Table 1. Result of various parameters of tomato ketchup samples with ± SD**

| Parameters/ Sample | Al Hana | Hayat | Khabura | Jumbo |
|---|---|---|---|---|
| pH | 3.7±0.09 | 3.6±0.07 | 3.6±0.16 | 3.8±0.09 |
| conductivity MS/cm | 5.49±0.04 | 7.26±0.03 | 8.71±0.02 | 5.38±0.015 |
| solubility in water % | 55.96±0.62 | 53.35±1.02 | 61.12±0.7 | 57.23±0.75 |
| solubility in acid % | 66.7±1.24 | 63.6±1.38 | 65.5±0.85 | 66.2±1.01 |
| Acidity (g/ 100 gm) | 3.2±0.05 | 3.84±0.04 | 4.01±0.07 | 4.01±0.05 |
| Moisture % | 35.05±0.7 | 35.23±0.9 | 38.23±0.4 | 39.2±1.1 |
| Ash % | 1.933±0.18 | 2.41±0.24 | 2.98±0.15 | 1.62±0.26 |
| Total acidity pH metry | 3.65 | 4.3 | 4.15 | 3.6 |
| Vitamic C(mg/100g) | 36.72±0.9 | 40.95±2.4 | 17.25±1.96 | 55.23±5.2 |
| Sodium ppm | 294.5±5.79 | 428.85±6.75 | 475.85±6.53 | 321.5±5.9 |
| Potassium ppm | 115±2.46 | 93.5±2.21 | 153.3±3.2 | 137±2.65 |
| Magnesium (mg/100 g) | 176±8.5 | 106±4.7 | 163±5.8 | 137±5.5 |
| Calcium (mg/100 g) | 117±3 | 97±2.9 | 67±1.8 | 94±2.1 |
| Viscosity (Pa s) | 4.50±0.25 | 6.76±0.36 | 3.93±0.16 | 4.17±0.16 |

**There was no significant difference (p > 0.05 and F = 0.032) between any two means between the samples and within the parameters. Results are mentioned mean of three readings ± SD value*

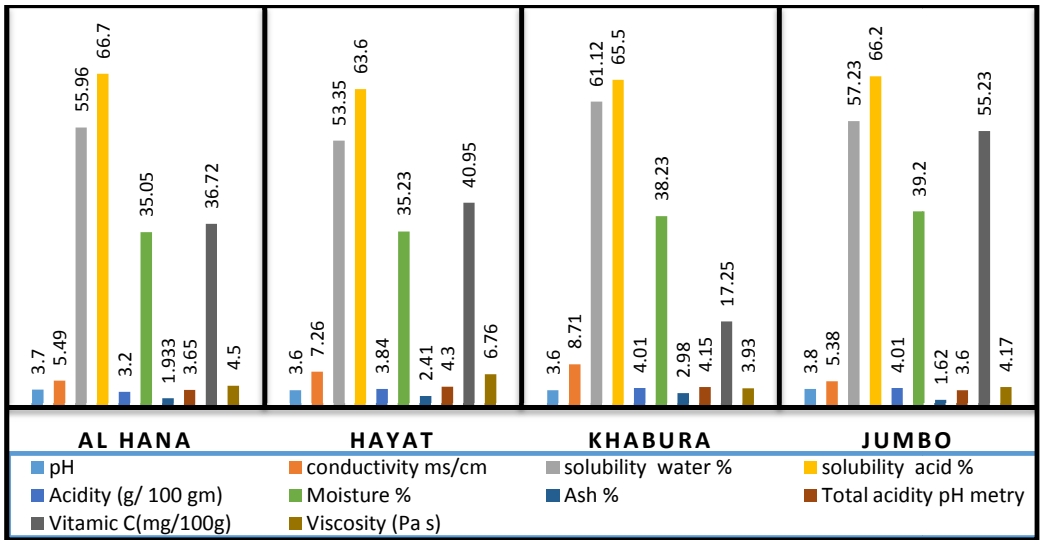


**Fig. 1. Comparison between various physico-chemical parameters**

### 3.1 Statistical Analysis

The p-value corresponding to the F-statistic of one-way ANOVA is higher than 0.05, suggesting that the treatments are not significant for that level of significance. F-value - 0.032 and p - 0.99.

Solubility of ketchup was tested for both water soluble and in dilute acid. It was found that water solubility in the range of 53.35±1.02–61.12±0.7% while in dilute acid 63.6±1.38–66.7±1.24%. Khabura sample found to higher solubility in water as well as acid solution. Acidity of the ketchup sample was measured in equivalent to citric acid in g/100 gm of sample. We found acidity of samples in the range of 3.2±0.05 – 4.01±0.07 g/100 gm of sample.

Acidity of all samples were measured by using pH metric titration method and graph of change in pH of the sample with every addition of NaOH was obtained. We obtained equivalence point from the graph for calculation of acidity. The acidity obtained from this method was found to be in the range of 3.6 (Jumbo) – 4.3 g/100 gm (Hayat) sample. We found that pH metric method was more reliable and accurate because the acidity obtained was correlating with range pH of the samples.

Moisture measured in all samples were found in the range of 35.05±0.7% (Al Hana) – 39.2±1.1% (Jumbo). These values were very close to standard value for ketchup. Ash % was found lowest amount 1.62±0.26% (Jumbo) while 2.98±0.15% highest in Khabura sample. The amount of ash represents inorganic materials as well as impurities. Viscosity is one important parameter used for testing force offered from the ketchup resistance to flow. It will impact on compact and flawless of the sample. Viscosity was found that Hayat sample was having highest viscosity i.e. 6.76±0.36 (Pa s) and Khabura sample was lowest in the viscosity i.e. 3.93±0.16 (Pa s). Vitamin C very useful in strengthening the immune system of human being. Highest amount of vitamin C was found in Jumbo sample i.e. 55.23±5.2 mg/100 gm and smallest in Khabura i.e. 17.25±1.96 mg/100 gm. We found good amount of vitamin C in all samples.

### 3.2 Mineral Analysis

We have measured different minerals in the sample such as sodium, potassium, magnesium and calcium. Sodium is not good for our health. It will effect on blood pressure. AL Hana found lowest amount of sodium i.e. 294.5±5.79 mg/100 gm while Khabura sample found highest amount of sodium i.e. 475.85±6.53 mg/100 gm. Comparison of different minerals present in the ketchup sample are shown in Fig. 2. Potassium is considered to be good for our health. The amount of potassium was found in the range of 93.5±2.21 mg/100 gm in sample Hayat and 153.3±3.2 mg/100 gm in sample Khabura. Calibration curve with equation of line and R2 value are shown in the Fig. 3 for sodium and Fig. 4 for potassium.

Magnesium was found in the range of 153.3±3.2 mg/100 gm in Hayat and 163±5.8 mg/100 gm in Al Hana sample. Calcium also consider as good for bones and the amount of calcium was found high in Al Hana (117±3) and lowest in Khabura sample (67±1.8) mg/100 gm of sample.

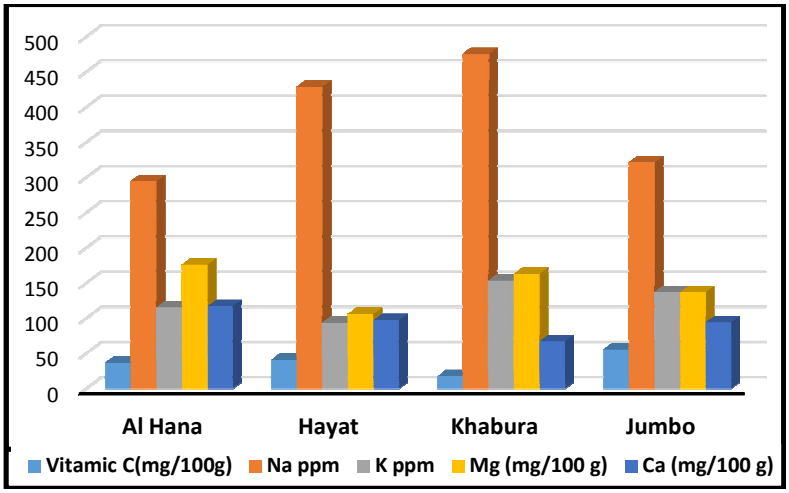


**Fig. 2. Analysis of minerals in tomato ketchup samples**

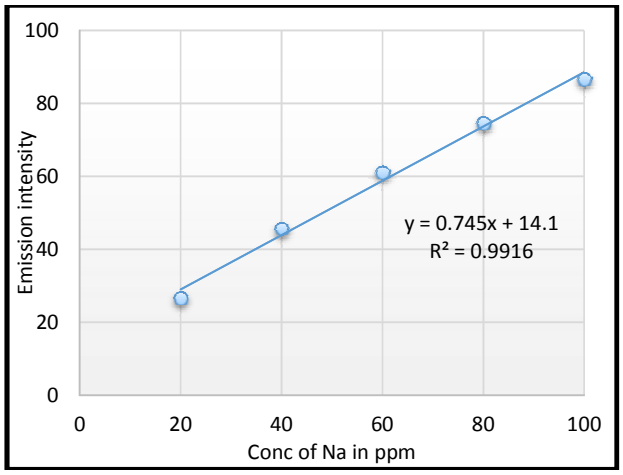


**Fig. 3. Analysis of sodium**

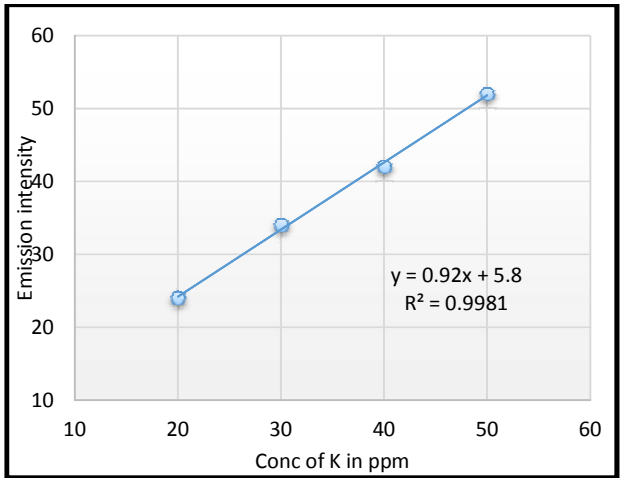


**Fig. 4. Analysis of potassium**

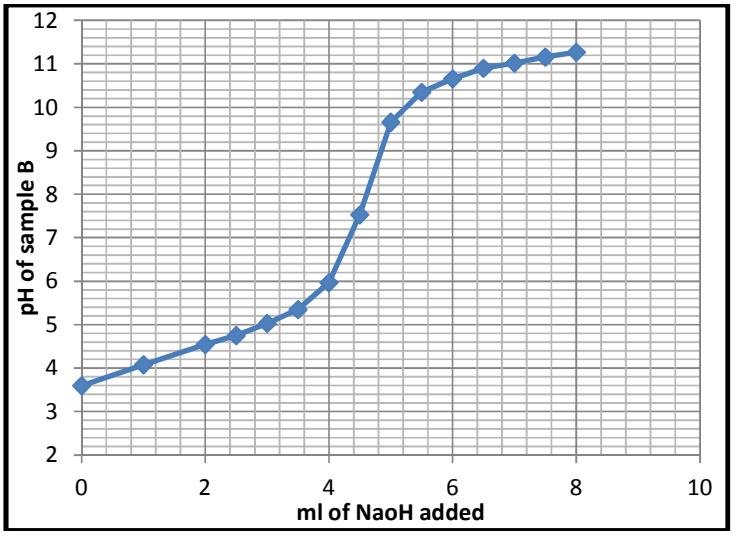


**Fig. 5. pH metric titration for measurement of acidity of ketchup**

## 4. CONCLUSION

On the basis of result obtained during the analysis of four tomato ketchup samples Jumbo sample was good amount of vitamin C, less ash value (sometimes high ash also due to impurities) and lowest sodium content. While AL Hana sample was good in less sodium and high amount of magnesium and calcium. But overall all samples were possessing more or less similar amount of nutritional fact.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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